

**Form ESA-B4. Summary Report for ESA-247-3**  
**Public Report - Final**

<b>Company</b>	Tootsie Roll Industries	<b>ESA Dates</b>	Dec 3-5, 2008
<b>Plant</b>		<b>ESA Type</b>	Compressed Air
<b>Product</b>		<b>ESA Specialist</b>	Greg Wheeler

**Brief Narrative Summary Report for the Energy Savings Assessment:**

**Introduction:**

The plant produces candies from sugar, milk, cocoa, corn syrup, natural and artificial flavors. Primary products include Tootsie Rolls, Lollipops, and Dots. Ingredients are mixed, cooked in steam-jacketed cookers, shaped, cured or dried, packaged and shipped.

**Objective of ESA:**

The objective of the ESA is to model the compressed air system using the AIRMaster+ software tool and to use the tool to identify savings from several measures that would improve system efficiency. It is not the objective of the ESA to look at all potential plant improvement opportunities.

**Focus of Assessment:**

The focus of the ESA is for plant personnel to understand how the appropriate DOE tool can be effectively applied in the plant. The focus of this ESA is the main compressed air system.

**Compressor Description:**

There are three (3) screw compressors in the target main system. Currently, two (North and South compressors) operate during production shift one; one (South 250 hp) operates during production shifts 2 and 3; and one (North 150 hp) operates on down days.

The compressed air system includes:

<b>Compressor Summary</b>							
#	Manufacturer	Model	acfm	Psig	hp	Type	Control
South	Ingersoll Rand	SSR-HP250	979	150	250	Lubricated Screw	Load-unload
North	Ingersoll Rand	SSR-EP150	670	125	150	Lubricated Screw	Load-unload
Sullair	Sullair	32/25-200L WCAC	979	150	250	Lubricated Screw	Spiral Valve with unloading
	System Totals		2,628		650		

**Dryer Description.**

Two (2) refrigerated dryers operate with dewpoint between 38 and 42F. Typically one operates during production. Dryers appear to operate efficiently. The air drying system includes:

Dryer Summary				
Qty	Manufacturer	Model	scfm	Description
1	Ingersoll-Rand	TM2500W	2500	Refrigerated dryer
1	Sullair	PSII-2500WC	2500	Refrigerated dryer

### **Distribution system description.**

The distribution system includes approximately 1,800 feet of header piping with diameters from 2" to 6". Header storage capacity is approximately 85 cubic feet (cf). There are four primary receivers at the compressors with total capacity of 200 cf. Two secondary receivers near applications add 25 cf each. Pressure drop from the compressor room to the north end of the plant is approximately 5 psi, including 5 micron filters intended primarily to capture water vapor in the event of dryer failure.

### **Control system description. .**

The two Ingersoll-Rand compressors have modulation with unloading controls, however they operate efficiently in load-unload mode. The South compressor took several minutes for the sump pressure to fall to 30 psig during unloaded operation. It typically reached 60 psig during the unloading cycles logged during the ESA visit. The plant team recommends repairing and adjusting the unloading controls to achieve the intended savings during unloaded operation.

The older Sullair compressor has spiral valve with unloading control. However, it did not appear to operate properly, not reaching full capacity. The plant team recommends repairing the Sullair compressor so that it can operate at full capacity if needed for backup.

### **Approach for ESA:**

1. Identify and understand the target system(s) and determine priorities for opportunities to pursue.
2. Identify critical flows, temperatures, pressures, areas, and other information that will be required for the analysis.
3. Gather available data and trend logs and develop a list of data that needs to be obtained from other sources or that needs to be measured.
4. Enter this data into the compressed air tools and check for internal consistency, such as with metered energy use. Data will be verified and adjusted, if necessary. Team members will enter data into the compressed air tools and check results for feasibility.
5. Acquire cost estimates from vendors if possible. Estimate range of improvement costs from previous plant and Qualified Specialist experience.
6. Demonstrate compressed air tools to interested participants.
7. Complete:
  - Plant Intake Questions
  - Summary Report
  - Software Tool Output
  - Evaluation

### **General Observations of Potential Opportunities:**

The following results and recommendations represent the best information available at the time. When current compressor design, performance specs, or fan curves were not available, they were estimated and scaled from generic specs and curves in AirMaster. Compressor current and pressure were logged for 2 days and then imported into the LogTool. Calculated airflows were compared with manual logs of a system airflow meter. Hourly-average power for each airflow was calculated from system voltage (480 V), power factor values from MotorMaster+, and logged current. Two daytypes were identified: Production and Down days. Down days were modeled as a separate system in AirMaster because pressure is reduced from 100 to 70 psig nominal on

Down days. The results and estimated savings are reasonable, but the plant team recommends getting more long-term operating data before modifying the compressed air system based on these results.

Results from the following four (4) Energy Efficiency Measures (EEM) from the scenario “Compressed Air Strategy” in AIRMaster are included.

Energy Savings Summary				
Identified Opportunity	kWh	Savings/year	Imp Cost	Payback (years)
		Total \$		
Adjust Cascading Set Points	78,500	\$6,600	\$0	0.0
Reduce Air Leaks	135,700	\$11,400	\$5,000	0.4
Replace Air with Blowers	85,400	\$7,200	\$10,000	1.4
Reduce System Air Pressure	49,000	\$4,100	\$0	0.0
Total	348,600	\$29,300	\$15,000	0.5

### Energy Efficiency Measures (EEM):

#### 1. Adjust Cascading Setpoints.

**Situation:** The South compressor (IR 250hp) is currently set as the lead compressor with a setpoint pressure range between 105 and 115 psig. The North Compressor (IR 150hp) is set as the lag compressor with a setpoint pressure range between 95 and 105 psig. The system pressure is approximately 10 psi higher when only the south compressor is operating, which was the case on 2<sup>nd</sup> and 3<sup>rd</sup> shifts during the ESA visit. This control strategy was implemented when the compressors were modulated with throttle control. The goal was to avoid having both compressors operating inefficiently at partload with overlapping control ranges. This strategy is not effective with load-unload control.

**Solution:** Reduce the pressure range for the South compressor to 97 to 107 psig. It will still operate as lead compressor but at lower pressure, reducing artificial air demand due to higher pressure and saving compressor power.

**Savings:** AIRMaster calculates savings to be approximately \$6,600/year. There is no cost to reset control setpoints. The payback is immediate.

#### 2. Reduce Air Leaks.

**Situation:** Air leaks can be heard and felt at several locations in the plant. Some leaks are in valves, hoses and fittings that are easily repaired. Others may be in cylinders and actuators that will need to be rebuilt or replaced and are more expensive to repair. Manual logs of system airflow on down days shows that the minimum airflow is 400 cfm. We assume that air leaks account for 300 cfm.

**Solution:** Tag and repair air leaks. An air leak generally costs around \$1,000/year at \$0.06/kWh by the time it can be heard. Fixing leaks is generally low cost in both time and materials, with paybacks typically less than one-year. Plant personnel estimated that air leaks could be reduced by 50% (150 scfm) with a cost of \$5,000.

**Savings:** The plant air system operates 8,760 hours/year. AIRMaster calculates savings to be \$11,400/yr with a 0.4-year payback.

### 3. Replace Compressed Air Nozzles with Blowers.

**Situation:** Compressed air is used to blow starch off candy on two machines. Each machine has two “spinners” with six (6) 1/16” holes each. We calculated airflow through each hole to be approximately 4 cfm at 50 psig. The two machines operate one shift during production hours. Air use is summarized in the following table.

Thirteen (13) Tootsie Roll forming machines have two open tubes that blow compressed air to align the rolls. An average of 7.6 machines operate during shift 1 and an average of 2.5 machines operate on the second and third shifts, as summarized in the following table.

Compressed Air Blowers			Machines Operating		Total cfm	
Description	Nozzles/machine	cfm/nozzle	Shift 1	Shift 2+3	Shift 1	Shift 2+3
Tootsie Roll Alignment Blowers	2	7	7.6	2.50	106	35
Starch Cleaners	12	4	2		96	0
Total					202	35

**Solution:** Consider replacing the compressed air systems with fan-type blowers that are designed to supply a variety of engineered nozzles and knives. We estimate that three blowers with combined 7.5 hp motors should be able to serve these machines more efficiently. Airflow reduction would be approximately 200 cfm during shift 1 and 35 cfm during shifts 2 and 3. We estimate the cost at \$10,000.

**Savings:** AirMaster calculates savings to be \$7,200/yr for a 1.4-year payback.

### 4. Reduce System Air Pressure

**Situation:** After adjusting the cascading setpoints, the compressors will operate between 95 and 107 psig. After filters and dryers, air is supplied to the plant at approximately 5 psi lower. While some of the equipment is believed to require 90 psig, other machines operate at lower pressures. Other air uses, such as pneumatic pumps, can operate as low as 60 psig

**Solution:** Consider reducing the discharge pressure at the compressors by 5 psi. Begin by reducing pressure in small steps, such as 1 psi, and continue if there are no problems. If a problem arises, consider the cost of resolving the problem versus the savings from reducing pressure. For example, add another secondary receiver near an end use to meet an intermittent load, modify piping, close a piping loop, or add a dedicated or booster compressor or amplifier to satisfy a critical or higher-pressure load.

**Savings:** Savings are approximately ¾% for each psi that pressure can be reduced, including power savings and reduced airflow in non-regulated applications. AirMaster calculates savings from reducing system pressure 5 psi to be approximately \$4,100. We assume no cost to reduce system pressure and payback is immediate.

### Operation and Maintenance Opportunities

Operation & Maintenance Opportunities
1. Replace incandescent lamps with compact fluorescent lamps. Even if they wander, they save energy wherever they are. An alternative is to replace alternate incandescent fixtures with T8 fluorescent fixtures.

## Other Measures Considered but not Recommended

Other Measures Considered	
1.	Consider adding approximately 1000 gals of primary receiver capacity at the compressors to improve unloading performance. Not recommended at this time because the savings were calculated to be approximately \$1000/yr
2.	Consider adding an automatic sequencer to control both compressors within a narrower pressure range. Savings come from approximately 3 psi reduction in average system pressure. Not recommended at this time because savings are approximately \$1,500/yr with cost greater than \$10,000, and the plant may not need to operate 2 compressors after implementing some EEMs
3.	Consider adding a smaller compressor for down days. Compressor should have low (~20%) no-load power. Consider a 2-stage, lubricant-free compressor because it would unload efficiently and avoid the expense of food-grade oil.

### Management Support and Comments:

Plant has a corporate energy manager and a target to reduce energy use by as much as possible.

**DOE Contact at Plant/Company:** (whom DOE would contact for follow-up regarding progress in implementing ESA results.)

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### Disclaimer

The work described in this report is funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program. The primary objective of the Energy Savings Assessments (ESA) is to train plant personnel to use USDOE software tools to identify and evaluate Energy Efficiency Measures (EEM) that would reduce plant energy use and costs. Some EEMs may require additional engineering design and capital investment. When engineering services are not available in-house, we recommend that a consulting engineering firm be engaged to provide design assistance as needed. In addition, since the site visits by the USDOE energy experts are brief, they are necessarily limited in scope.

The energy expert believes this report to be a reasonably accurate representation of energy use and opportunities in this plant. However, because of the limited scope of the visit, the U.S. Department of Energy and the energy expert cannot guarantee the accuracy, completeness, or usefulness of the information contained in this report, nor assume any liability for damages resulting from the use of any information, equipment, method or process disclosed in this report.